# Winging It

## Using Digital Imaging to Investigate Butterfly Metamorphosis

*By Anne Bowen and Randy L. Bell*

**Subject:** Biology

**Audience:** Teachers, teacher educators, staff developers

**Grade Level:** 9–12 (Ages 14–18)

**Technology:** Digital camera, digital microscope

**Standards:** *NETS•S* 3; *NETS•T* II (http://www.iste.org/standards/). *NSES* Content Standards Grades 9–12 C (http://books.nap.edu/html/nses/html/).

All pictures were taken by Anne's students with a digital camera or digital microscope.

One of the best ways to inspire interest in biology is, not surprisingly, through observations of living things. Unfortunately, this important component of science methodology is often left out because of the difficulty of including it in the classroom. Additionally, amazing processes occur in nature that few have the chance to observe. In this article, Randy and I review a research project we created and that I then integrated with instruction about life cycles as a student teacher in a high school biology classroom. We focus in particular on the use of digital images in the lesson. Find a brief overview of the lesson on p. 26.

### Use of Digital Images

In the science classroom, digital imaging tools can facilitate scientific inquiry and thinking by making observations more accessible and permanent. My students used digital cameras and digital microscopes to capture images from each step in the life cycle of the painted lady butterfly. These images supplemented the students' detailed journal notes and sketches, documenting their observations of the painted ladies' daily appearances and behaviors.

***Digital Camera.*** In recent years, digital cameras have crossed the threshold of affordability and ease of use, making them suitable for wide-scale use in classrooms. Most of my students had used a digital camera before. In fact, they often were perfectionists, taking pictures repeatedly to capture the "perfect" image.

I found it useful to have a digital camera available in class every day so students could capture unpredictable behaviors and changes of the butterflies. Each class had its own set of

disks, and students used those disks to save their images. They also kept a record of the picture files and who took each picture.

The digital camera allowed students to take close-up shots of the painted lady in its four life stages: caterpillar (larva), chrysalis (pupa), adult, and egg. They took pictures of adult pairs mating and adult females laying eggs. They also used the digital camera to take images of the butterfly habitat and students working on different aspects of the research. In this way, the digital camera was essential in documenting the "grand scheme" of the project.

***Digital Microscope.*** My students used a QX3 digital microscope, which proved to be an essential tool in this project. They were able to take still pictures magnified at 10x, 60x, and 200x as well as time-lapse and real-time video. Students used the video features to capture images of the butterflies during their transitions between metamorphic stages. They also removed the optical assembly from the stand and used it as a handheld digital camera or to capture time-lapse video of subjects too large to fit on the microscope stage.

For example, a key moment in the project was the metamorphosis of the caterpillar into its chrysalis. Students observed the behavior exhibited by the caterpillar just before it makes the change, realizing that it will hang in a J, or hook, shape from the top of its container. This behavior served as an important indicator of when to start recording video.

To record the video, students secured the optical component of the microscope to a cardboard box stage, focused on the hanging caterpillar, and set the microscope to take a time-lapse image every 20 seconds. At the end of class we watched the movie. Amidst exclamations of "wow," "gross," "cool," and "it looks like something from that movie, *Tremors*," the students watched on the computer screen as the caterpillar wriggled from its exoskeleton, revealing the chrysalis underneath. (***Editor's note:*** You can see the time-lapse video on the Web on Days 10–12 of the Butterfly Project Research Timeline. For this and other URLs, see Resources on p. 27.) Most of us did not realize the details of the incredible process by which the butterfly chrysalis is revealed until watching this time-lapse movie. Students in other classes watched the movie, and inspired by the amazing footage, they attempted to record movies of their own. A similar process transpired as the students recorded a time-lapse image of the adult painted lady emerging from its chrysalis.

Using the microscope was both exciting and frustrating to students. As one student remarked, "It was cool to use new technology." However, capturing a time-lapse image proved more difficult than many students had anticipated. Often, we would leave the time-lapse running after school, in hopes that the adult would emerge in that time. Because the QX3 is equipped with a finite recording space per movie, we changed our settings to a longer lapse time in order to be able to record for an extended period of time. Students did not like this limitation, feeling restricted after they had discovered the optimal lapse time for capturing this process. However, this provided an excellent teaching moment for me, and we had a discussion about the limitations of technology.

Adult painted lady butterfly on host plant.

Painted lady habitat setup with digital microscope on the right.

Handheld QX3 taking time-lapse shots of chrysalis inside habitat.

Students really enjoyed taking magnified still images with the digital microscope. They took photos of the butterflies' hairy bodies and scaly wings, the painted lady eggs, and the newborn caterpillars—barely visible at first—hatched from the tiny eggs.

Finally, they recorded movies of different butterfly behaviors. Videos of adult butterflies slurping nectar from a cotton wick revealed the probing motion of the butterflies' uncurled proboscises.

## Significance of Digital Images

The digital images (both still and video) taken during this research project were very useful. For one, some of the processes (e.g., chrysalis formation) are made more observable in time-lapse imagery, which speeds up the process considerably. Also, sometimes a behavior (e.g., chrysalis formation, mating, egg laying) took place during certain classes but not others or even after school. With the movie saved on the computer, all students were able to see images of these processes. Additionally, magnified images of the eggs, wing scales, and newborn caterpillars revealed details invisible to the naked eye. A few students remarked that they were amazed when they observed that the "dust" on butterfly wings was actually tiny scales that line the wings.

Finally, if resources are not available in the future to conduct the same project with live butterflies, the saved images and movies will be useful for instructional purposes in future classes.

An important use of the students' images was in the communication of their findings to the rest of the class. Students learned that sharing knowledge with others in the community is a vital part of scientific research. Images showing what the students actually saw during the life cycle of the butterfly were extremely effective in communicating the process. Students created a Butterfly Research Web

Behavior captured digitally in two classes was available for viewing in other classes.

Adult painted ladies mating.

Female laying eggs.

### TIME LINE FOR THE LESSON

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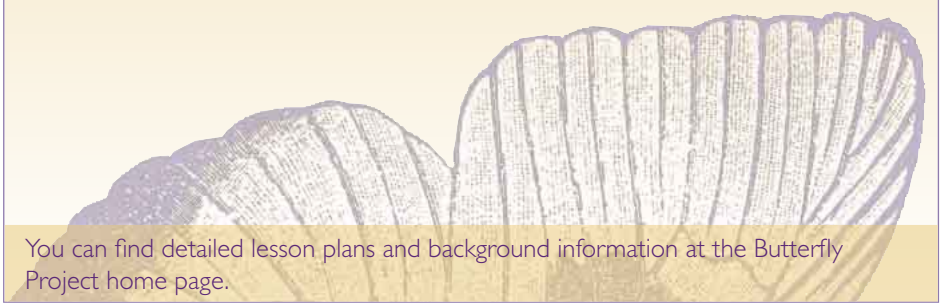
| Day 1 | Nature of science lesson and introduction to project |
| Day 2 | Introduction to science journals, meet the caterpillars |
| Days 3–10 | Observations of the caterpillars, introduction to digital cameras |
| Days 10–12 | Introduction to microscope functions, capturing chrysalis formation |
| Days 12–18 | Setting up habitat for adults emerging, time-lapse photography to capture emergence |
| Days 18–20 | Adults emerging and time-lapse photography |
| Days 18–22 | Identifying species, mating, introduction to life history reports |
| Days 22–24 | Laying eggs, digital images and movies |
| Days 24–29 | Caterpillars hatch, microscope images, work on reports |
| Day 30 | Scientific methods and reports due, begin Web site design |



You can find detailed lesson plans and background information at the Butterfly Project home page.

Students used the microscope to take magnified images.

Caterpillar hanging in "J-shape," 10x.

Painted lady eggs, 200x.

Newborn caterpillar, 60x.

site using their images and movies to share the information.

Also, the saved images of the life cycle stages were used by students in their final life history report for the metamorphosis of the painted lady. This made the final word processed document "come to life," and the students were more excited about their product than had it been a simple, unillustrated report.

According to the students, using the technology was both fun and informative. Many students expressed their wish for "more time using the technology." They felt a great sense of accomplishment in recording images. For example, one student who captured an exemplary digital camera image admitted that she "felt really proud that the picture came out so well and would be used on the Web site." In hopes that they might be able to capture a spectacular image, some students would visit the classroom between classes, during lunch, and even during other classes to check on their butterflies or work with the digital microscope. One student reported that this project "was a good way to do a hands-on approach to something that was (luckily) not a textbook thing. Not only was it fun, but it was educational." Another student added, "It was a fun experience, and it was cool how we used the new technology, such as the QX3 microscopes!"

More than anything else, we were pleased with the way digital imaging supported my focus on the content knowledge and process skills associated with life cycles. Rather than focusing on "chalk and talk" and book learning, the hands-on approach put students at the center of the activities and made the topic of life cycles come alive. Digital imaging supported students' efforts by allowing them to record and publish very detailed observations with minimal effort. Furthermore, through time-lapse videos, students were able to extend their observations in ways that would not be possible without technology. In the end, my students began to see themselves as "painted lady" experts and developed greater respect for the importance of observation and technology in the development of scientific knowledge. And as one student slyly remarked at the end of the project, "Sometimes it's good to wing it in science!"

## Acknowledgement

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## Resources

Butterfly Project: http://www.teacherlink.org/content/science/class_examples/Bflypages/

Butterfly Project Timeline Days 10–12: http://www.teacherlink.org/content/science/class_examples/Bflypages/timlinepages/day10_12.htm

Butterfly Research: http://www.k12albemarle.org/AlbemarleHS/ClassPages/Otis/butterflypages/butterflypage.htm

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